Endoparasites of Eleven Species of Ranid Frogs (Anura: Ranidae) from Papua New Guinea[1]

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Abstract: Two hundred eighty-eight ranid frogs from Papua New Guinea collected from 2002 to 2005 were examined for endoparasites: *Platymantis adiastolus*, *P. boulengeri*, *P. browni*, *P. gilliardi*, *P. papuensis*, *P. schmidti*, *Rana daemeli*, *R. garritor*, *R. jimiensis*, *R. milneana*, and *R. papua*. Found were one species of Cestoda (as cysticerci), three species of Digenea (*Opisthioglyphe cophixali*, *Diplodiscus amphichrus*, and *Mesocoelium monas*), 18 species of Nematoda (adults of *Abbreviata oligopapillata*, *Aplectana krausi*, *Aplectana macintoshii*, *Aplectana zweifeli*, *Cosmocerca novaeguineae*, *C. tyleri*, *Desmognathinema papuensis*, *Falcaustra papuensis*, *Icosiella papuensis*, *Meteterakis crombiei*, *Ochoterenella papuensis*, *Paracapillaria spratti*, *Pseudorictularia dipsarilis*, *Rhabdias australiensis*, *Seuratascaris numidica*, larvae of *Abbreviata* sp., and Ascaridae gen. sp.), two species of Acanthocephala (*Acanthocephalus bufonis* and cystacanths of a second species), and one species of Pentastomida (nymphs of *Kiricephalus* sp.). Sixty-seven new host records, one new country record, and several new island records are reported. Nematodes composed 18/24 (75%) of the species present. Thirteen of the 24 endoparasite species found currently appear to be endemic to Papua New Guinea.

The family Ranidae has an almost worldwide distribution and is well represented in Papua New Guinea, where eight genera with more than 50 species have been reported (Menzies 2006). To our knowledge endoparasite records are available for seven Papua New Guinean ranid species: *Platymantis boulengeri*, *P. nexipus*, *P. papuensis*, *Rana arfaki*, *R.* "*grisea*," *R. grunniens*, and *R. supragrisea* (Schmidt 1975, Moravec and Sey 1989, 1990, Bursey and Goldberg 2007, Bursey et al. 2008, 2009). In this paper we present endoparasitological records for six species of *Platymantis* (*P. adiastolus* Brown, Richards, Sukumaran & Foupoulos, 2006; *P. boulengeri* [Boettger, 1892]; *P. browni* Allison & Kraus, 2001; *P. gilliardi* Zweifel, 1960; *P. papuensis* Meyer, 1875; *P. schmidti* Brown & Tyler, 1968) and five species of *Rana* (*R. daemeli* [Steindachner, 1868]; *Rana garritor* Menzies, 1987; *Rana jimiensis* Tyler, 1963; *Rana milneana* Loveridge, 1948; *Rana papua* Lesson, 1827), and we establish the initial helminth lists for *P. adiastolus*, *P. browni*, *P. gilliardi*, *P. schmidti*, *R. daemeli*, *R. garritor*, *R. jimiensis*, *R. milneana*, and *R. papua*.

MATERIALS AND METHODS

Two hundred eighty-eight frogs representing 11 species of Ranidae collected by hand in Papua New Guinea from 2002 to 2005 were examined for endoparasites: *Platymantis adiastolus* ($n = 22$), *P. boulengeri* ($n = 41$), *P. browni* ($n = 24$), *P. gilliardi* ($n = 12$), *P. papuensis* ($n = 53$), *P. schmidti* ($n = 33$), *Rana daemeli* ($n = 24$), *R. garritor* ($n = 26$), *R. jimiensis* ($n = 11$), *R. milneana* ($n = 25$), and *R. papua* ($n = 17$). These ranid species all came from

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the main island of New Guinea, with the exception of *Platymantis papuensis*, which all came from the offshore island of New Britain, and *Rana daemeli*. Immediately after capture frogs were euthanized, fixed in neutral buffered 10% formalin, stored in 70% ethanol, and accessioned in the herpetology collection of the Bernice P. Bishop Museum (BPBM), Honolulu, Hawai'i (Appendix 1). Subsequently, the body cavity was opened by a longitudinal abdominal incision and the gastrointestinal tract was removed by cutting across the esophagus and the rectum and then shipped in a vial of alcohol to Whittier College, Whittier, California, where a detailed dissection of each part of the tract was carried out using a dissecting microscope. Endoparasites from individual hosts were removed to vials of 70% ethanol and later placed under a coverslip in a drop of lactophenol and allowed to clear. Nematodes and acanthocephalans were identified from these preparations. Digeneans, cestodes, and pentastomes were washed in water, regressively stained in hematoxylin, and mounted in balsam for identification under a compound microscope. Parasite terminology is in accordance with Bush et al. (1997): prevalence (number infected hosts/number hosts examined × 100), mean intensity (mean number of helminths per infected host ± 1 standard deviation). Voucher specimens were deposited in the U.S. National Parasite Collection (USNPC), Beltsville, Maryland, or the Bernice P. Bishop Museum (BPBM) (Appendix 2).

RESULTS

A total of 3,644 endoparasites was recovered from 229 (80%) of 288 frogs. Of these, 2,790 (77% of total) were mature individuals representing three species of Digenea (*Diplodiscus amphichrus* Tubangui, 1933; *Mesocoelium monas* [Rudolphi, 1819] Freitas, 1957; *Opisthioglyphe cophixali* Moravec & Sey, 1989); 15 species of Nematoda (*Abbreviata oligopapillata* [Kreis, 1940] Morgan, 1945; *Aplectana krausi* Bursey & Goldberg, 2007; *Aplectana macintoshii* [Stewart, 1914] Travassos, 1931; *Aplectana zweifeli* Moravec & Sey, 1986; *Cosmocerca novaeguineae* Moravec & Sey, 1990; *Cosmocerca tyleri* Bursey, Goldberg & Kraus, 2006; *Desmognathinema papuensis* Moravec & Sey, 1990; *Falcaustra papuensis* Bursey, Goldberg & Kraus, 2007; *Icosiella papuensis* Johnston, 1967; *Meteterakis crombiei* Bursey, Goldberg & Kraus, 2005; *Ochoterenella papuensis* Johnston, 1967; *Paracapillaria spratti* [Moravec & Sey, 1986]; *Pseudorictularia dipsarilis* [Irwin-Smith, 1922] Dollfus & Desportes, 1944; *Rhabdias australiensis* Moravec & Sey, 1990; *Seuratascaris numidica* [Seurat, 1917]; and one species of Acanthocephala (*Acanthocephalus bufonis* [Shipley, 1903]). Also present were 854 (23% of total) juvenile endoparasites presumably incapable of completing their life cycles in frogs: one species of Cestoda (as cysticerci), two species of Nematoda (*Abbreviata* sp. and Ascaridae gen. sp.), one species of Acanthocephala (as cystacanths), and one species of Pentastomida (nymphs of *Kiricephalus* sp.). Number of parasites, prevalence, mean intensity and range of infection, site of infection, and new host records are given in Table 1.

Although 24 species of endoparasites occurred in the sample, no host species harbored more than 13 species of endoparasites (mean number of endoparasite species per host species was 7.1 ± 3.4, range 4–13), and no individual frog harbored more than nine endoparasite species (mean number of endoparasite species per infected frog was 1.9 ± 1.2, range 1–9).

DISCUSSION

All but two of the host species examined in this study are endemic to New Guinea and adjacent islands, reflecting the high level of endemism found in the Papuan biota (range maps for host taxa available at http://www.bishopmuseum.org/research/pbs/papuanherps/). As a result, it was not surprising to also discover a high degree of endemism among the helminths found in these frogs.

Of the digenean species found in this study, two species have wide geographic distribution and one species appears to be endemic. *Diplodiscus amphichrus* was described

from specimens taken from several unidentified species of *Rana* collected in the Philippine Islands by Tubangui (1933). It is widely distributed in Asian frogs, having been reported from the Philippines, Vietnam, India, Korea, China, and Taiwan (Prudhoe and Bray 1982). *Mesocoelium monas* is cosmopolitan in distribution and is known from fishes, amphibians, and reptiles; records are summarized in Bursey et al. (2007*c*). *Opisthioglyphe cophixali* was originally described by Moravec and Sey (1989) from a microhylid frog, *Cophixalus parkeri*, collected on Mt. Otto, Papua New Guinea. It is curious that it should occur in our samples of *Platymantis* from offshore New Britain Island but not be found in our *Rana* samples from New Guinea, the island from which it was first described. This may perhaps reflect ecological differences inasmuch as *Cophixalus* and *Platymantis* are direct developers, whereas species of *Rana* lay eggs in water and have a tadpole stage. No other hosts have previously been reported.

Cestode cysticerci have been reported in *Cyrtodactylus louisiadensis* and *Rana supragrisea* (as "*Sylvirana supragrisea*") from Papua New Guinea (Bursey et al. 2005, 2008). Because these larvae occurred in cysts and caused no obvious cellular damage, we believe frogs can serve as paratenic hosts. Typically, these larvae when ingested by a definitive host would complete their life cycles (see Roberts and Janovy 2005).

Twelve of the nematode species found are currently known only from Papua New Guinea, three are found in the Australo-Papuan region, and two have wide distributions. *Abbreviata oligopapillata* was originally described as *Physaloptera oligopapillata* by Kreis (1940) from specimens taken from the skink *Sphenomorphus jobiensis* collected on New Britain, Bismarck Archipelago, but was assigned to *Abbreviata* by Morgan (1945). Jones (1979) reported it in an elapid snake, *Acanthophis antarcticus*, collected on New Guinea. *Aplectana krausi* was recently described from *P. boulengeri* from East New Britain Province, Papua New Guinea, by Bursey and Goldberg (2007). Our new records all came from congeneric hosts from the same island. *Aplectana macintoshii* is the most widely distributed member of the genus and is known from Africa, Europe, Southeast Asia, Japan, and South America; hosts are summarized in Bursey et al. (2008). It was originally described as *Oxysoma macintoshii* from specimens taken from *Rana tigrina* (currently *Hoplobatrachus tigerinus*) and *Bufo stomaticus* collected in India by Stewart (1914) and was reassigned to *Aplectana* by Travassos (1931). *Aplectana zweifeli* was described by Moravec and Sey (1986) from the frog *Phrynomantis humicola* (currently *Callulops humicola*) collected in Papua New Guinea. Bursey et al. (2005) found it in the skink *Sphenomorphus jobiensis* from Papua New Guinea. New Britain represents a new island record. *Cosmocerca novaeguineae* was originally described by Moravec and Sey (1990) from specimens taken from *Platymantis papuensis* collected in West Sepik Province, Papua New Guinea. New Britain represents a new island record. *Cosmocerca tyleri* was described by Bursey et al. (2006) from specimens taken from the microhylid frog *Genyophryne thomsoni* collected in the Cloudy Mountains, Milne Bay Province, Papua New Guinea. It was reported in the microhylid frog *Hylophorbus* cf. *rufescens* from Milne Bay Province, Papua New Guinea, by Bursey et al. (2007*b*). Our new record is also from that province. *Desmognathinema papuensis* was described from *Rana "grisea"* from Eastern Highlands Province by Moravec and Sey (1990). Bursey et al. (2008) reported it in *Rana supragrisea* (as "*Sylvirana supragrisea*") from Mt. Simpson, Milne Bay Province, Papua New Guinea. *Falcaustra papuensis* was described from the scincid lizard *Sphenomorphus simus* from Papua New Guinea by Bursey et al. (2007*a*). New Britain represents a new island record. *Icosiella papuensis* was described from *P. papuensis* from Papua New Guinea by Johnston (1967). Bursey et al. (2008) reported it in *Rana supragrisea* (as "*Sylvirana supragrisea*") from Normanby Island, Milne Bay Province, Papua New Guinea. *Meteterakis crombiei* was described from the skink *Sphenomorphus jobiensis* from Papua New Guinea by Bursey et al. (2005). New Britain represents a new island record. *Ochoterenella papuensis* was described from *Platymantis papuensis* by John-

TABLE 1

Number (N), Prevalence (P as a percentage), Mean Intensity and 1 Standard Deviation and Range (MI ± SD [R]) for Endoparasites Found in 11 Species of Ranid Frogs (*Platymantis* and *Rana*) from Papua New Guinea

Host:	*P. adiastolus* $n = 22$			*P. boulengeri* $n = 41$			*P. browni* $n = 24$			*P. gilliardi* $n = 12$		
Endoparasite	N	P	MI ± SD (R)	N	P	MI ± SD (R)	N	P	MI ± SD (R)	N	P	MI ± SD (R)
Digenea												
Diplodiscus amphichrus			—			—			—			—
Opisthioglyphe cophixali	*31	36	3.9 ± 2.6 (1–9)	*9	7	3.0 ± 2.0 (1–5)			—	*3	17	1.5 ± 0.7 (1–2)
Mesocoelium monas			—	*24	5	12.0 ± 14.1 (2–22)			—			—
Cestoda												
Gen. sp. (cysticerci)	*24	5	24 (---)	*166	12	33.2 ± 24.9 (7–69)			—			—
Nematoda												
Abbreviata oligopapillata			—	*49	17	7.0 ± 6.0 (1–18)			—			—
Aplectana krausi	*9	10	4.5 ± 5.0 (1–8)	676	83	19.9 ± 44.4 (1–260)	*1	4	1 (---)	*1	8	1 (---)
Aplectana macintoshii			—			—			—			—
Aplectana zweifeli	*12	5	12 (---)	*1	2	1 (---)			—			—
Cosmocerca novaeguineae	*125	59	9.6 ± 5.5 (1–21)	*63	34	4.5 ± 3.5 (1–12)	*37	63	2.5 ± 1.5 (1–6)	*134	83	13.4 ± 15.3 (3–55)
Cosmocerca tyleri			—			—			—			—
Desmognathinema papuensis			—			—			—			—
Falcaustra papuensis			—	*12	7	4.0 ± 2.7 (2–7)			—			—
Icosiella papuensis			—			—			—			—
Meteterakis crombiei	*19	5	19 (---)	*245	24	24.5 ± 21.9 (3–77)			—			—
Ochoterenella papuensis	*1	5	1 (---)			—	*14	17	3.5 ± 2.9 (1–6)			—
Paracapillaria spratti			—			—			—			—
Pseudorictularia dipsarilis			—			—			—			—
Rhabdias australiensis			—	*1	2	1 (---)			—			—
Seuratascaris numidica	*1	5	1 (---)			—	*1	4	1 (---)			—
Abbreviata sp. (larva)	*26	27	4.3 ± 3.3 (2–11)	*6	12	1.2 ± 0.5 (1–2)			—	*1	8	1 (---)
Ascaridae gen. sp. (larva)	*18	9	10.7 ± 8.8 (2–22)	*39	20	4.9 ± 6.7 (1–20)			—			—
Acanthocephala												
Acanthocephalus bufonis			—			—			—			—
Centrorhynchid cystacanths	*43	24	3.6 ± 2.4 (1–7)			—			—	*1	8	1 (---)
Pentastomida												
Nymphs			—	*11	5	5.5 ± 0.7 (5–6)			—			—

Host:	*P. papuensis* $n = 51$				*P. schmidti* $n = 33$				*R. daemeli* $n = 24$				*R. garritor* $n = 26$			
Endoparasite	N	P	MI ± SD	(R)	N	P	MI ± SD	(R)	N	P	MI ± SD	(R)	N	P	MI ± SD	(R)
Digenea																
Diplodiscus amphichrus			—				—		*1	4	1	(---)			—	
Opisthioglyphe cophixali			—		*189	48	11.8 ± 22.5	(1–89)			—				—	
Mesocoelium monas	*1	2	1	(---)	*1	9	2.0 ± 1.0	(1–3)			—		*1	4	1	(---)
Cestoda																
Gen. sp. (cysticerci)			—		*97	24	12.1 ± 19.7	(1–60)			—				—	
Nematoda																
Abbreviata oligopapillata			—				—				—				—	
Aplectana krausi			—		*224	36	18.7 ± 35.1	(1–126)			—				—	
Aplectana macintoshii	*36	12	6.0 ± 1.7	(5–9)			—				—				—	
Aplectana zweifeli			—				—				—				—	
Cosmocerca novaeguineae	413	76	10.6 ± 10.4	(1–40)	*167	64	7.9 ± 5.8	(1–20)			—		*4	8	2.0 ± 0.0	(---)
Cosmocerca tyleri			—				—				—				—	
Desmognathinema papuensis			—				—				—				—	
Falcaustra papuensis	*1	2	1	(---)			—				—				—	
Icosiella papuensis			—				—				—				—	
Meteterakis crombiei			—		*13	12	3.3 ± 3.3	(1–8)	*1	4	1	(---)			—	
Ochoterenella papuensis	7	4	3.5 ± 3.5	(1–6)			—				—				—	
Paracapillaria spratti			—		*1	3	1	(---)			—				—	
Pseudorictularia dipsarilis			—		*3	6	1.5 ± 0.7	(1–2)	1	4	1	(---)			—	
Rhabdias australiensis	*1	2	1	(---)			—				—				—	
Seuratascaris numidica			—		*1	3	1	(---)			—		*40	50	3.1 ± 3.2	(1–11)
Abbreviata sp. (larva)	*89	22	8.1 ± 9.9	(1–28)	22	24	2.8 ± 2.6	(1–8)	*14	25	2.3 ± 1.9	(1–6)	*9	19	1.8 ± 0.8	(1–3)
Ascaridae gen. sp. (larva)			—		*128	30	12.8 ± 12.6	(1–34)			—				—	
Acanthocephala																
Acanthocephalus bufonis			—				—		*4	2	1.3 ± 0.6	(1–2)			—	
Centrorhynchid cystacanths			—				—				—				—	
Pentastomida																
Nymphs			—		*1	3	1	(---)			—				—	

TABLE 1 (continued)

Host:	*R. jimiensis* $n = 11$				*R. milneana* $n = 25$				*R. papua* $n = 17$			
Endoparasite	N	P	MI ± SD	(R)	N	P	MI ± SD	(R)	N	P	MI ± SD	(R)
Digenea												
Diplodiscus amphichrus			—				—				—	
Opisthioglyphe cophixali			—				—				—	
Mesocoelium monas			—		*4	8	2.0 ± 1.4	(1–3)			—	
Cestoda												
Gen. sp. (cysticercus)			—		29	19	7.3 ± 6.7	(1–14)			—	
Nematoda												
Abbreviata oligopapillata			—				—				—	
Aplectana krausi			—				—				—	
Aplectana macintoshii			—				—				—	
Aplectana zweifeli			—				—		11	6	11	(---)
Cosmocerca novaeguinae	*2	11	1.0 ± 0.0	(--)	*41	48	3.4 ± 3.0	(1–9)	*37	59	3.7 ± 2.0	(1–7)
Cosmocerca tyleri			—		*1	4	1	(---)			—	
Desmognathinema papuensis	37	72	4.6 ± 5.1	(1–16)			—		2	6	2	(---)
Falcaustra papuensis			—				—				—	
Icosiella papuensis			—		*2	8	1.0 ± 0.0	(---)			—	
Meteterakis crombiei			—				—				—	
Ochoterenella papuensis			—		*33	8	16.5 ± 21.9	(1–32)			—	
Paracapillaria spratti			—				—				—	
Pseudorictularia dipsarilis			—				—				—	
Rhabdias australiensis			—				—				—	
Seuratascaris numidica			—				—		*1	6	1	(---)
Abbreviata sp. (larva)	2	9	2	(---)	*32	32	4.0 ± 3.8	(1–12)	*96	59	9.6 ± 17.0	(1–55)
Ascaridae gen. sp. (larva)			—				—				—	
Acanthocephala												
Acanthocephalus bufonis	6	36	1.5 ± 0.6	(1–2)	*17	19	4.3 ± 2.1	(2–6)			—	
Centrorhynchid cystacanths			—				—				—	
Pentastomida												
Nymphs			—				—				—	

*, New host record.

TABLE 2

Known Endoparasites of Papua New Guinean Ranid Frogs

Parasite \ Host	*Platymantis adiastolus*	*Platymantis boulengeri*	*Platymantis browni*	*Platymantis gilliardi*	*Platymantis nexipus*	*Platymantis papuensis*	*Platymantis schmidti*	*Rana arfaki*	*Rana daemeli*	*Rana garritor*	*Rana grisea*	*Rana grunniens*	*Rana jimiensis*	*Rana milneana*	*Rana papua*	*Rana supragrisea*
Papua New Guinea only																
Dolichosaccus grandiacetabularis	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--
Dolichosaccus longibursatus	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--
Halipegus zweifeli	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--
Opisthioglyphe cophixali	2	2	--	2	3	--	2	--	--	--	--	--	--	--	--	--
Proteocephalus niuginii	--	--	--	--	--	--	--	4	--	--	--	--	--	--	--	--
Proteocephalus papuensis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6
Aplectana krausi	2	2, 7	2	2	3	--	2	--	--	--	--	--	--	--	--	--
Aplectana zweifeli	2	2	--	--	--	--	--	--	--	--	--	--	--	--	2	--
Cosmocerca novaeguineae	2	2	2	2	3	2, 5	2	--	--	2	--	--	2	2	2	6
Cosmocerca tyleri	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	--
Desmognathinema papuensis	--	--	--	--	--	--	--	--	--	--	5	--	2	--	2	--
Falcaustra batrachiensis	--	--	--	--	3	--	--	--	--	--	--	--	--	--	--	--
Falcaustra papuensis	--	2	--	--	--	2	--	--	--	--	--	--	--	--	--	--
Icosiella papuensis	--	--	--	--	3	8	--	--	--	--	--	--	--	2	--	6
Meteterakis crombiei	2	2	--	--	--	--	2	--	2	--	--	--	--	--	--	--
Ochoterenella papuensis	2	--	2	--	--	2, 8	--	--	--	--	--	--	--	2	--	--
Oswaldocruzia bakeri	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6
Paracapillaria spratti	--	--	--	--	--	--	2	--	--	--	--	--	--	--	--	6
Australo-Papuan																
Abbreviata oligopapillata	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pseudorictularia dipsarilis	--	--	--	--	--	--	2	--	2	--	--	--	--	--	--	6
Rhabdias australiensis	--	2	--	--	--	2	--	--	--	--	--	--	--	--	--	--
Rokroknema novaebritanniae	--	--	--	--	3	--	--	--	--	--	--	--	--	--	--	--
Australo-Papuan and elsewhere																
Diplodiscus amphichrus	--	--	--	--	--	--	--	--	2	--	--	--	--	--	--	--
Mesocoelium monas	--	2	--	--	--	2	2	--	--	2	--	--	--	2	--	--
Aplectana macintoshii	--	--	--	--	--	2	--	--	--	--	--	--	--	--	--	6
Seuratascaris numidica	2	--	2	--	--	--	2	--	--	2	--	--	--	--	2	6
Spinitectus ranae	--	--	--	--	--	--	--	--	--	--	--	5	--	--	--	--
Acanthocephalus bufonis	--	--	--	--	--	--	--	--	2	--	--	--	2	2	--	6
Species not maturing in frogs																
Cestoda (cysticercus)	2	2	--	--	--	--	2	--	--	--	--	--	--	2	--	6
Abbreviata sp. (larva)	2	2	--	2	3	2	2	--	2	2	--	--	2	2	2	6
Ascaridae (larva)	2	2	--	--	--	--	2	--	--	--	--	--	--	--	--	--
Physocephalus sp. (larva)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6
Spinicaudinae (larva)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6
Acanthocephala (cystacanths)	2	--	--	2	3	--	--	--	--	--	--	--	--	--	--	6
Kiricephalus sp. (nymphs)	--	2	--	--	--	--	2	--	--	--	--	--	--	--	--	6

Note: Numerals refer to references: 1, Moravec and Sey (1989); 2, this paper; 3, Bursey et al. (2009); 4, Schmidt (1975); 5, Moravec and Sey (1990); 6, Bursey et al. (2008); 7, Bursey and Goldberg (2007); 8, Johnston (1967).

ston (1967) from Papua New Guinea. New Britain represents a new island record. *Paracapillaria spratti* was described from the microhylid frog *Callulops stictogaster* from Papua New Guinea by Moravec and Sey (1986). It also was recorded from *Callulops humicola* by Moravec (1990). New Britain represents a new island record. *Pseudorictularia dipsarilis*

was described from the scincid lizard *Pseudemoia entrecasteauxii* from Flinders Island, South Australia, by Irwin-Smith (1922). Other hosts are listed in Bursey et al. (2008) and include frogs, lizards, and a mammal from Australia. *Rhabdias australiensis* was described by Moravec and Sey (1990) from *Rana daemeli* collected in Queensland, Australia. Papua New Guinea is a new locality record, and New Britain is a new island record. *Seuratascaris numidica* is known from a variety of anurans from Europe, the Orient, and Australia (see Baker 1987).

Larval nematodes found during this study require invertebrate intermediate hosts; thus it is probable that infection occurs by ingesting infected insects. Encysted larvae of *Abbreviata* sp. were found in the stomach wall of the frogs examined in this study, and ascarid larvae were found in the coelom, but these larvae are also common in the gastric tissues and body cavities of lizards and snakes from Australia (Jones 1995). Anurans most likely serve as paratenic hosts.

Acanthocephalus bufonis was originally described as *Echinorhynchis bufonis* from individuals taken from *Bufo melanostictus* in Thailand (Shipley 1903). Hosts for *A. bufonis* are listed in Bursey et al. (2008). Acanthocephalan cystacanths develop in an arthropod intermediate host until they become infective; infection occurs through ingestion, and in inappropriate hosts cystacanths migrate from the digestive tract into the body cavity and re-encyst (Schmidt 1985).

Adults of *Kiricephalus pattoni* inhabit respiratory passageways of numerous Indian, Southeast Asian, and Australian snakes (Riley and Self 1980); adults of *Kiricephalus tortus* are known only from New Guinea (Shipley 1898). Hosts for adults of these two species as well as hosts of nymphs are listed in Bursey et al. (2008).

As noted earlier, an important behavioral difference between the two genera of frogs examined in this study is that *Rana* species deposit eggs in water and these develop into tadpoles, whereas *Platymantis* species deposit eggs on land, where direct development occurs (Menzies 2006). Currently, 35 helminth species are known from Papua New Guinean ranid frogs (Table 2). Of these, 22 species occur in *Platymantis* and 27 species in *Rana;* however, only 14 species occur in both genera, which produces a Sorensen similarity index of 55 for the two genera. Whether the difference in endoparasitic species harbored by these hosts results from different developmental strategies or other behaviors will require further study, although our results for *Opisthioglyphe cophixali* suggest that this might be the case.

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Appendix 1

Ranid Frog Specimens from Papua New Guinea Examined from the Herpetology Collection of the Bernice P. Bishop Museum (BPBM), Honolulu, Hawai'i, or Fred Kraus Field Tag (FK)

Platymantis adiastolus ($n = 22$), East New Britain Province: 11.3 km NNW Marmar (BPBM 22211), 9 km NNW Marmar (BPBM 22362, 22365, 22366, 22369–22380), 2.6 km NNW Marmar (BPBM 22383–22388).

Platymantis boulengeri ($n = 41$), East New Britain Province: 0–9.5 km NNW Mamar (BPBM 22212–22221, 22223–22332, 22334–22337, 22343, 22345–22348, 22350–22361).

Platymantis browni ($n = 24$), East New Britain Province: 9 km NNW Marmar (BPBM 22229–22246, 22248, 22250–22252, 22256, 22257).

Platymantis gilliardi ($n = 12$), East New Britain Province: 8.8–11.3 km NNW Marmar (BPBM 22259–22666), 2.6 km NNW Marmar (BPBM 22267–22270).

Platymantis papuensis ($n = 52$), Milne Bay Province: Alotau, Kinahidamadamana River (BPBM 15467), 9.5 km W Alotau (BPBM 15469–15476), Top of Huhuna Road, 300 m (BPBM 15478–15481, 16287–16304, 17078–17082, 17825, 17826, 18513–18515, 22799–22808); West Sepik Province: Parkop (FK 11404).

Platymantis schmidti ($n = 33$), East New Britain Province, Marmar (BPBM 22279, 22281–22292, 22294–22306, 22308, 22363, 22364, 22381, 22382, FK 10977, 10978).

Rana daemeli ($n = 24$), Milne Bay Province: Alotau (BPBM 15482), Nigila 13.7 km E Alotau (BPBM 15483–15486), Halowia 15.8 km E Alotau (BPBM 16305, 16307, 16308, 16309–16311, 16313, 16314), Alotau, Kinahidamadamana River (BPBM 163615, 16316), Kivikivi (BPBM 17074); East New Britain Province: Pomio (BPBM 22391–22398).

Rana garritor ($n = 26$), Milne Bay Province: SE slope Mt. Pekopekowana (BPBM 15488–15490, 15492–15499, 15501–15513), Cloudy Mts., Upaelisafupi Stream (BPBM 15746, 15747).

Rana jimiensis ($n = 11$), West Sepik Province: Torricelli Mts., SSW slope Mt. Sapau (BPBM 22831–22839, 22841, 22842).

Rana milneana ($n = 25$), Milne Bay Province: Alotau, Kinahidamadamana River (BPBM 15749, 15750, 16377–16380), SE slope Mt. Pekopekowana (BPBM 15751–15753), Fergusson Island (BPBM 16360–16363), Normanby Island (BPBM 16366, 16372–16376, 17075–17077); Central Province: Iamarere (BPBM 22399–22401).

Rana papua ($n = 17$), Milne Bay Province: Normanby Island, Sewa Bay (BPBM 16321–16326, 16329–16335, 16896); West Sepik Province: Parkop (BPBM 22843–22845).

Appendix 2

Helminths from Papua New Guinea Deposited in the U.S. National Parasite Museum (USNPC), Beltsville, Maryland, or the Bernice P. Bishop Museum (BPBM), Honolulu, Hawai'i

Platymantis adiastolus: *Opisthioglyphe clophixali* (USNPC 100859); cestode cysticercus (USNPC 100860); *Aplectana krausi* (USNPC 100861); *Aplectana zweifeli* (USNPC 100862); *Cosmocerca novaeguineae* (USNPC 100863; BPBM H282); *Meteterakis crombiei* (USNPC 100864); *Ochoterenella papuensis* (USNPC 100865); *Seuratascaris numidica* (USNPC 1000866); *Abbreviata* sp. (USNPC100867; BPBM H280); ascarid larvae (USNPC 100868; BPBM H281); Acanthocephala cystacanth (USNPC 100869).

Platymantis boulengeri: Mesocoelium monas (USNPC 100870; BPBM F299); *Opisthioglyphe ophixali* (USNPC 100871, 100872; BPBM F300, F301, F302); Cestoda cysticercus (USNPC 100873, 100874; BPBM F303); *Abbreviata oligopapillata* (USNPC 100875, 100876; BPBM H283, H284); *Aplectana krausi* (USNPC 100877, 100878; BPBM H285, H286); *Aplectana zweifeli* (USNPC 100879); *Cosmocerca novaeguineae* (USNPC 100880); *Falcaustra papuensis* (USNPC 100881; BPBM H287); *Meteterakis crombiei* (USNPC 100882; BPBM H288); *Rhabdias australiensis* (USNPC 100883); *Abbreviata* sp. (USNPC 100884; BPBM H289); ascarid larvae (USNPC 100885, 100886; BPBM H290, H291); Pentastomida nymph (USNPC 100887; BPBM H292).

Platymantis browni: *Aplectana krausi* (USNPC 100888); *Cosmocerca novaeguineae* (USNPC 100889; BPBM H293); *Ochoterenella papuensis* (USNPC 100890; BPBM H294); *Seuratascaris numidica* (USNPC 100891).

Platymantis gilliardi: *Opisthioglyphe cophixali* (USNPC 100892; BPBM F304); *Aplectana krausi* (USNPC 100893); *Cosmocerca novaeguineae* (USNPC 100894; BPBM H295); *Abbreviata* sp. (USNPC 100895); Acanthocephala cystacanth (USNPC 100896).

Platymantis papuensis: *Mesocoelium monas* (USNPC

100897); *Aplectana krausi* (USNPC 100898); *Cosmocerca novaeguineae* (USNPC 100899; BPBM H296); *Falcaustra papuensis* (USNPC 100900); *Ochoterenella papuensis* (USNPC 100901; BPBM H297); *Abbreviata* sp. (USNPC 100902; BPBM H298).

Platymantis schmidti: *Mesocoelium monas* (USNPC 100903; BPBM F305); *Opisthioglyphe cophixali* (USNPC 100904; BPBM F306, F307); Cestoda cycticercus (USNPC 100905; BPBM F308, F309); *Aplectana krausi* (USNPC 100906; BPBM H299); *Cosmocerca novaeguineae* (USNPC 100907); *Meteterakis crombiei* (USNPC 100908); *Paracapillaria spratti* (USNPC 100909); *Pseudorictularia dipsarilis* (USNPC 100910); *Abbreviata* sp. (USNPC 100911); ascarid larvae (USNPC 100912; BPBM H300); Pentastomida nymph (USNPC 100913).

Rana daemeli: *Diplodiscus amphichrus* (USNPC 100914); *Meteterakis crombiei* (USNPC 100915).

Rana garritor: *Mesocoelium monas* (USNPC 100916; BPBM F310); *Abbreviata* sp. (USNPC 100917; BPBM H301).

Rana jimiensis: *Cosmocerca novaeguineae* (USNPC 100918); *Desmognathinema papuensis* (USNPC 100919; BPBM H302); *Abbreviata* sp. (USNPC 100920); *Acanthocephalus bufonis* (USNPC 100921; BPBM H303).

Rana milneana: *Mesocoelium monas* (USNPC 100922; BPBM F311); Cestoda, cysticercus (USNPC 100923; BPBM F312); *Icosiella papuensis* (USNPC 100924); *Ochoterenella papuensis* (USNPC 100925; BPBM H304).

Rana papua: *Aplectana zweifeli* (USNPC 100926); *Desmognathinema papuensis* (USNPC 100927; BPBM H305); *Seuratascaris numidica* (USNPC 100928); *Abbreviata* sp. (USNPC 100929; BPBM H306).